

V.A.9 Fuel Cell Testing at Argonne National Laboratory

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The initial performance establishes a baseline for comparison as the fuel cell ages. The aging process is accelerated to yield a reasonable projection of life at constant power and under driving duty cycles in a reasonable amount of testing time. Periodically during the aging test, the test is interrupted and the stack performance is characterized. A life projection is then made by comparing the most recent performance characteristics with those measured earlier.

In this task, we are also part of Working Group 11 under Technical Committee 105 of the International Electrotechnical Commission. Kazuo Koseki (Japan) is the Convener and Ira Bloom is the Secretary. The goal of this international group is to draft a technical specification of a single-cell test protocol. The first meeting will be held on June 26-27, 2007, in Fayetteville, NC. Representatives from four to five countries plan to attend.

Objectives

- To provide DOE with an independent assessment of the performance of fuel cell systems and components developed under DOE contracts.
- To benchmark commercial fuel cell technology developments.

Technical Barriers

This project addresses the following technical barriers from Fuel Cells section (3.4.4) of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- (A) Durability
- (G) Start-up and Shut-down Time and Energy/Transient Operation

Technical Targets

This project helps DOE document progress toward achieving its technical targets by providing an independent assessment of evolving fuel cell hardware. In addition, the project develops standard fuel cell testing procedures to aid in the evaluation of different stack technologies. In these procedures, the stack is characterized in terms of initial performance, durability, and low-temperature performance (future work). These procedures are compared with similar procedures developed by other national and international organizations.

Accomplishments

- Characterized a complete 5-kW system.
- Characterized a 5-kW, state-of-the-art stack (in progress).
- Enhanced the facility's cooling system to handle high cell temperatures, up to 130°C.



Introduction

Independent fuel cell testing provides unbiased assessments of the state of development of fuel cell technology. The procedures and methods used are transparent to the technology being tested; thus, they provide a means for easy comparison of the performance and expected life of the technology from many different developers.

Approach

Standardized fuel cell stack test procedures have to be developed to aid in the evaluation of different stack technologies for potential use in automotive applications. These test procedures characterize the stack in terms of initial performance (e.g., power and voltage vs. current, hydrogen cross-over), durability, and low-temperature performance.

The test facility is flexible enough to accommodate the unique needs of different technologies. The modification of the facility is an ongoing process and is done in consultation with fuel cell developers and DOE.

Results

The complete 5-kW system was characterized by sequential and random polarization experiments, respectively. The results are shown in Figure 1. In the former, some hysteresis was observed. It is interesting to note that, in the latter polarization curve, the performance of the system appears to be higher than that seen in the former experiment.

After the characterization experiments, the system was tested for durability using two sets of test protocols. The first set was based on the developer's experience and consisted of a series of on-off cycles. For example, the system was turned on for 12 hours and then off for 12 hours or on for 1 hour and then off for 23 hours. The second set consisted of using DOE's driving duty cycle, the Dynamic Stress Test (DST). In the DST, six current levels were used, as shown schematically in Figure 2.

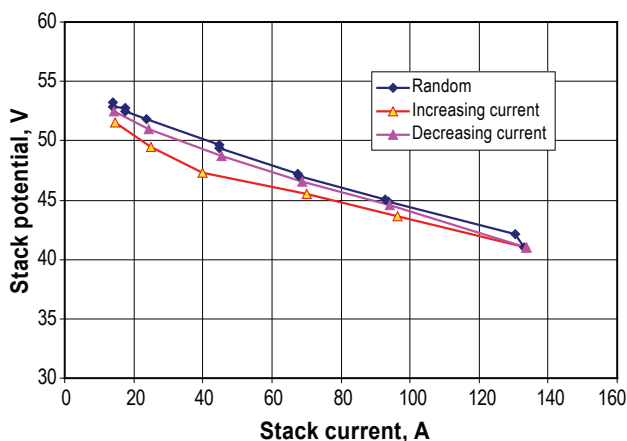


FIGURE 1. Random and Sequential Polarization Curves

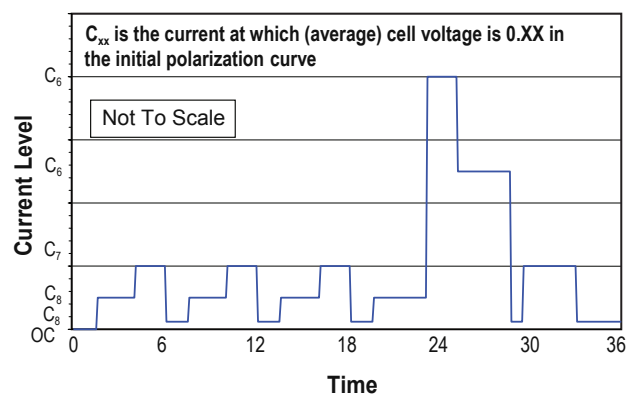


FIGURE 2. Schematic of DST Driving Duty Cycle

After every 100-120 hours, using either test protocol, the cycling was stopped and the sequential polarization experiment (reference performance test) was repeated to gauge performance changes in the system. These results are shown in Figure 3. The stack voltage at 500 mA/cm² is shown in Figure 4, in which the initial slope of the curve appears to depend on time at high voltages ("idle" time). After 800 hours of DST cycling, the stack performance degraded rapidly.

This test ended after the voltage had degraded by about 10% from the start of the DST cycling. The rated lifetime of the system was 1,000 hours; the total cycling time was 1,148 hours.

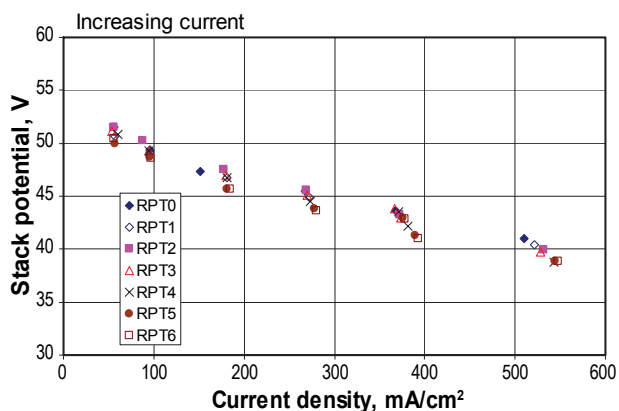


FIGURE 3. Summary of polarization curves measured during the reference performance tests. RPT0 = start; no aging; RPT1, RPT2 = 1 hour on/23 hours off; RPT3, RPT4 = 12 hours on/12 hours off; and RPT5, RPT6 = DST duty cycle.

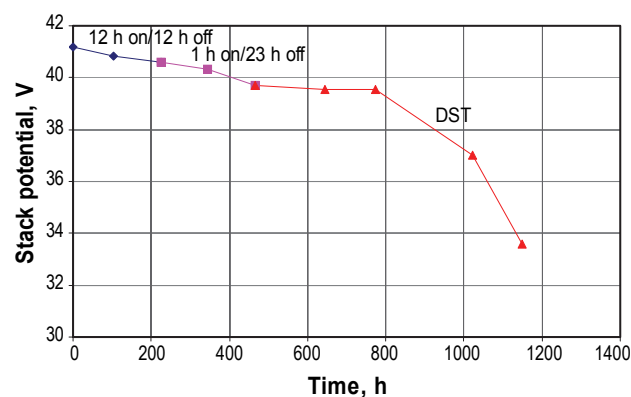


FIGURE 4. Stack Potential at 500 mA/cm² vs. Time During the Durability Tests

Conclusions and Future Directions

- Continue to characterize DOE fuel cell contract deliverables.
- Continue to benchmark other fuel cell technologies.
- Continue to collaborate with other fuel cell testing laboratories, such as Los Alamos National Laboratory, and Fuel Cell Systems Testing, Safety & Quality Assurance (FCTes^{QA}).
- Continue to work with Working Group 11 to draft the technical specification for a single-cell test protocol.